



Rise and Shiny, a new dawn for HTA

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Before we start ...

Disclaimer:

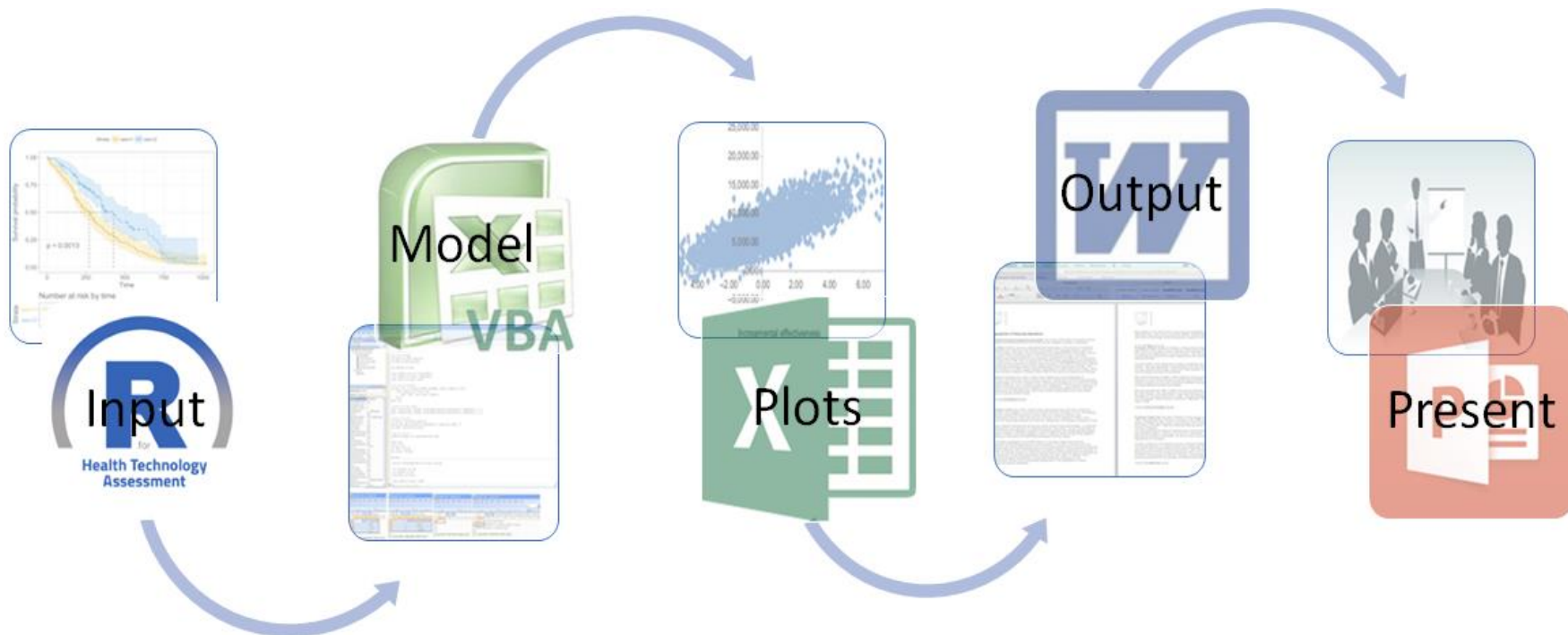
*The **views in this presentation** are those of the author, not of the University of Sheffield or the Joint Biosecurity Centre.*

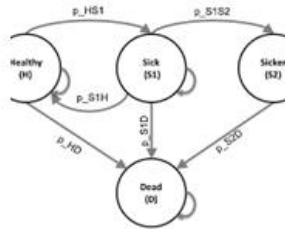
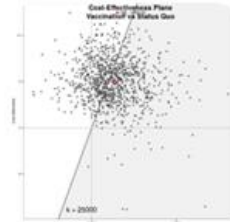
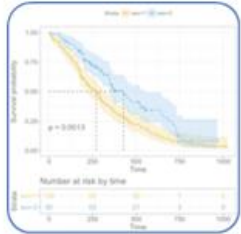
Grant information:

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Current Process

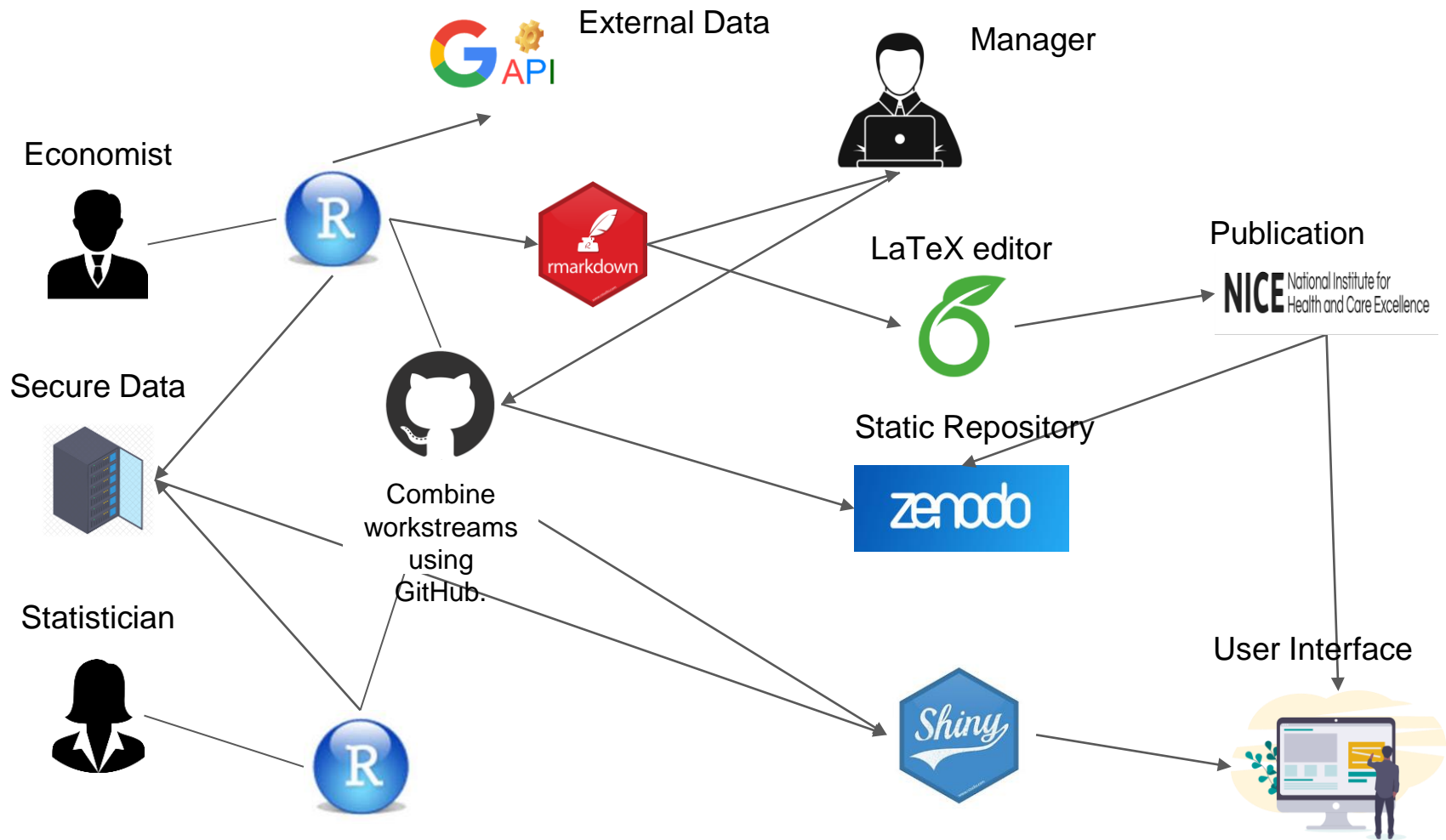




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simultaneous and/or surrogate data for medical innovations and current and emerging, including medical technologies is the responsibility of national health research organizations. The National Health and Medical Research Council (NH&MRC) is charged with the difficult task of identifying and evaluating emerging technologies, and making recommendations to guide NH&MRC research funding. The NH&MRC is also responsible for the development of the national health innovation in health technologies. Nevertheless, the current progress of health technology are far beyond what is before to systematically improve important aspects of value for health care. The current progress of health technology are far beyond what is before to systematically improve important aspects of value for health care. The current progress of health technology are far beyond what is before to systematically improve important aspects of value for health care.







Future Process: Benefits



1. One click update + transcription error reduction.
2. Speed of model creation (hence R not C++, time is money)!
3. Computational power (Rcpp) - VOI, analysis.
4. Code/data separation, testing independent of data.
5. Transparency - especially where publicly funded.
6. Reach & replication, one worldwide model on remote server.
7. Stakeholder engagement - Shiny + expert elicitation.



Graphical User Interface



Monthly Auto Sales Report

	January	February	March	QTR 1	April	May	June
Sheila W.	166,000	182,000	204,600		182,500	174,500	
Mark T.	152,000	177,000	158,000		183,750	201,000	
Shane S.	174,500	162,000	189,750		177,000	168,750	
John K.	201,000	199,000	182,500		162,000	182,000	
Bob M.	168,750	173,250	183,750		166,000	177,000	
Totals			=SUM(D5:D9)				
Average Monthly Totals							
Largest Monthly Sales							
Minimum Monthly Sales							

```
120 I.state<-const.ID=1000
121 I.state<-const.ID=1000
122 event<-const.ID=1000
123 event<-const.ID=1000
124 colnames(event, const) = event.name
125
126 # Probability pattern will switch
127 event.switch<-const.ID=1000
128 colnames(event.switch, const) = event
129 # Only switch after 1000
130 event.switch<-const.ID=1000
131 # Only switch after 1000
132 event.switch<-const.ID=1000
133 # Only switch after 1000
134 # Only switch after 1000
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163 # Only switch after 1000
164 # Only switch after 1000
165 # Only switch after 1000
166 # Only switch after 1000
```

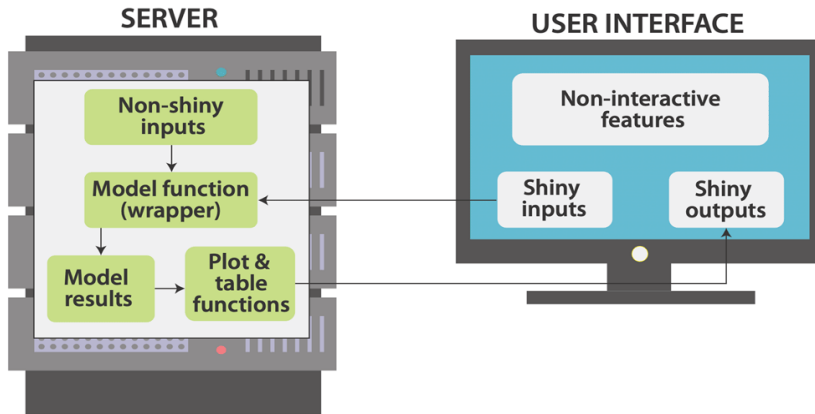
“... that code looks scary” (Anon, 2020)



Open-source tutorial



ShinyApp function



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METHOD ARTICLE

REVISED Making health economic models Shiny: A tutorial [version 2; peer review: 2 approved]

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* Equal contributors

[Author details](#)

Abstract

Health economic evaluation models have traditionally been built in Microsoft Excel, but more sophisticated tools are increasingly being used as model complexity and computational requirements increase. Of all the programming languages, R is most popular amongst health economists because it has a plethora of user created packages and is highly flexible. However, even with an integrated development environment such as R Studio, R lacks a simple point and click user interface and therefore requires some programming ability. This might make the switch from Microsoft Excel to R seem daunting, and it might make it difficult to directly communicate results with decisions makers and other stakeholders.

The R package Shiny has the potential to resolve this limitation. It allows programmers to embed health economic models developed in R into interactive web browser based user interfaces. Users can specify their own assumptions about model parameters and run different scenario analyses, which, in the case of regular a Markov model, can be computed within seconds. This paper provides a tutorial on how to wrap a health economic model built in R into a Shiny application. We use a four-state Markov model developed by the Decision Analysis in R for Technologies in Health (DARTH) group as a case-study to demonstrate main principles and basic functionality.

A more extensive tutorial, all code, and data are provided in a [GitHub repository](#).

Keywords

Health Economics, R, RShiny, Decision Science

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Paper: <https://wellcomeopenresearch.org/articles/5-69>
Code: https://github.com/RobertASmith/healthecon_shiny



Open-source tutorial



Inputs \longrightarrow Function \longrightarrow Outputs

Parameters		
c_s1	cost1	3
c_s2	cost2	5
c_H	cost3	6
dr	Dis_rate	0.035
n_sim	No. psa	1000

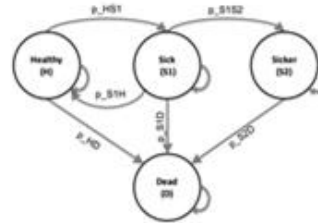
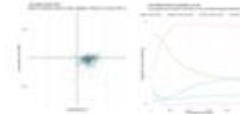


Figure 1: State-transition diagram of the two-independent Sick-Richter cohort state-transition model with the names of the health states and possible transitions with their corresponding transition probabilities.

Results Table

Option	QALYs	Costs	Inc.QALYs	Inc.Costs	ICER
Treatment	18.30	101108.37	0.63	1432.25	2291.80
No Treatment	17.63	86884.18	NA	NA	NA



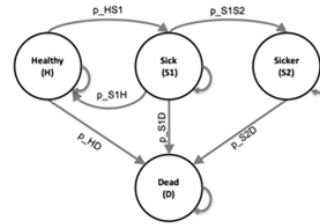


Open-source tutorial



Inputs \longrightarrow Function \longrightarrow Outputs

Parameters		
c_s1	cost1	3
c_s2	cost2	5
c_H	cost3	6
dr	Dis_rate	0.035
n_sim	No. psa	1000



Results Table

Option	QALYs	Costs	Inc.QALYs	Inc.Costs	ICER
Treatment	18.56	101106.37	0.63	1422.23	2320.60
No Treatment	17.93	99684.14	NA	NA	NA

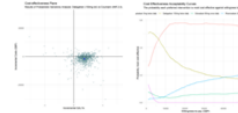


Figure 1: State-transition diagram of the time-independent Sick-Sicker cohort state-transition model with the name of the health states and possible transitions with their corresponding transition probabilities.



Treatment Cost

PSA runs

Initial age



UI code



```
ui <- fluidPage (    # creates empty page
```

```
# title of app
```

```
titlePanel("Sick Sicker Model in Shiny"),
```

```
# layout is a sidebar-layout
```

```
sidebarLayout(
```

```
# open sidebar panel
```

```
< SIDEBAR PANEL CODE >
```

```
# open main panel
```

```
< MAIN PANEL CODE >
```

```
) # close sidebarlayout
```

```
) # close UI fluidpage
```

Sick Sicker Model in Shiny

Treatment Cost
200

PSA runs
1000

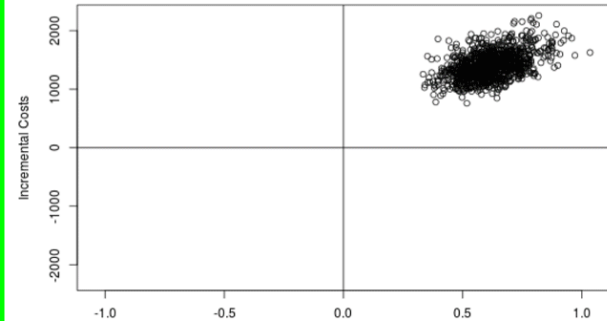
initial age
10 25 80

Run / update model

Results Table

Option	QALYs	Costs	Inc.QALYs	Inc.Costs	ICER
Treatment	18.59	100441.67	0.62	1406.24	2324.54
No Treatment	17.97	99035.43	NA	NA	NA

Cost-effectiveness Plane





Sidebar Panel Code



```
sidebarPanel( # open sidebar panel

  numericInput(inputId = "SI_c_Trtr",
               label = "Treatment Cost",
               value = 200,
               min = 0,
               max = 400),

  numericInput(inputId = "SI_n_sim",
               label = "PSA runs",
               value = 1000,
               min = 0,
               max = 400),

  sliderInput(inputId = "SI_n_age_init",
              label = "Initial Age",
              value = 25,
              min = 10,
              max = 80),

  # action button runs model when pressed
  actionButton(inputId = "run_model",
               label = "Run model")

) # close sidebarPanel
```

The screenshot shows a sidebar panel with three input controls and an action button. The first control is a text input labeled "Treatment Cost" with the value 200. The second is another text input labeled "PSA runs" with the value 1000. The third is a slider input labeled "initial age" with a range from 10 to 80 and a current value of 25. Below these inputs is a button labeled "Run / update model".



Main Panel Code

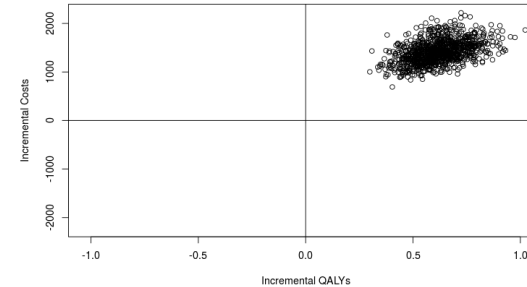


```
mainPanel(  
  
# heading (results table)  
h3("Results Table"),  
  
# tableOutput id = icer_table, from server  
tableOutput(outputId = "SO_icer_table"),  
  
# heading (Cost effectiveness plane)  
h3("Cost-effectiveness Plane"),  
  
# plotOutput id = SO_CE_plane, from server  
plotOutput(outputId = "SO_CE_plane")  
  
) # close mainpanel
```

Results Table

Option	QALYs	Costs	Inc.QALYs	Inc.Costs	ICER
Treatment	18.61	101016.42	0.62	1412.82	2335.56
No Treatment	17.99	99603.60	NA	NA	NA

Cost-effectiveness Plane





Server Code



```
server <- function(input, output){

  observeEvent(input$run_model, # WHEN ACTION BUTTON PRESSED
    ignoreNULL = F, {

    # Run model function with Shiny inputs
    df_model_res = f_wrapper(c_Trt = input$SI_c_Trt,
                             n_age_init = input$SI_n_age_init,
                             n_sim = input$SI_n_sim)

    #— CREATE COST EFFECTIVENESS TABLE —#
    # renderTable continuously updates table
    output$SO_icer_table <- renderTable({ < ICER TABLE FUNCTION > }) # table plot end.

    #— CREATE COST EFFECTIVENESS PLANE —#
    # render plot repeatedly updates.
    output$SO_CE_plane <- renderPlot({ < CE PLANE FUNCTION > }) # renderplot end

  }) # Observe event end

} # Server end
```



Simple app



Sick Sicker Model in Shiny

Treatment Cost

200

PSA runs

1000

initial age

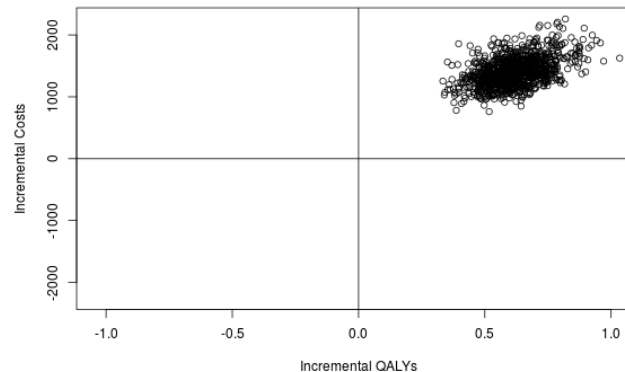
10 25 80

Run / update model

Results Table

Option	QALYs	Costs	Inc.QALYs	Inc.Costs	ICER
Treatment	18.59	100441.67	0.62	1406.24	2324.54
No Treatment	17.97	99035.43	NA	NA	NA

Cost-effectiveness Plane



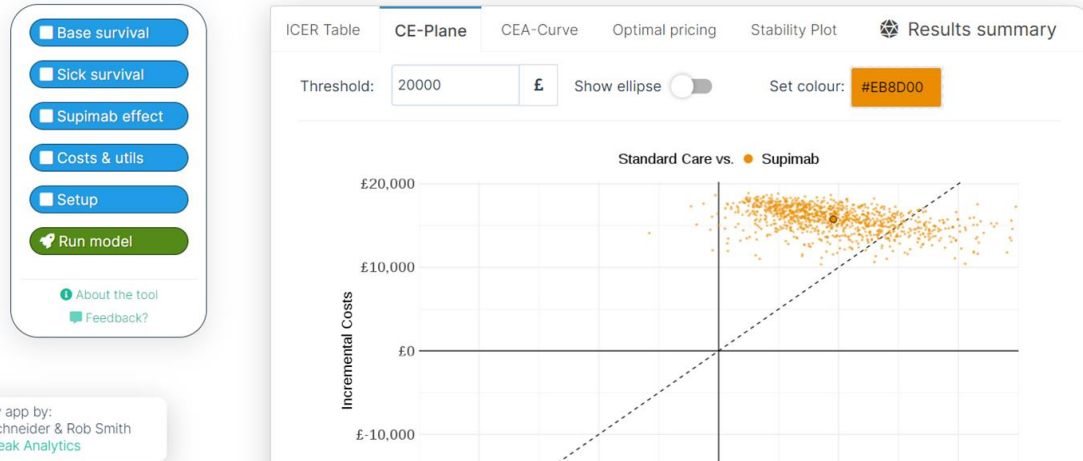
https://robertasmith.shinyapps.io/sick_sicker



More sophisticated app



A lean shiny app for a simple markov model - [beta 1.0](#)



A shiny app by:
Paul Schneider & Rob Smith
[Dark Peak Analytics](#)

<https://darkpeakanalytics.shinyapps.io/sadm-mk2/>



Open-source materials



Simple materials:

App: https://robertasmith.shinyapps.io/sick_sicker/
Paper: <https://wellcomeopenresearch.org/articles/5-69>
Code: https://github.com/RobertASmith/paper_makeHEshiny
Tutorial: https://r-hta.org/tutorial/markov_models_shiny/

More advanced materials:

App: <https://darkpeakanalytics.shinyapps.io/sadm-mk2/>
Code: <https://github.com/bitowaqr/sadm-mk2>
Package: <https://github.com/RobertASmith/darkpeak>





Thanks from Sheffield



Git: <https://github.com/RobertASmith>
Web: <https://www.darkpeakanalytics.com/>
Email: rasmith3@sheffield.ac.uk
LinkedIn: <https://www.linkedin.com/in/robert-smith-53b28438/>